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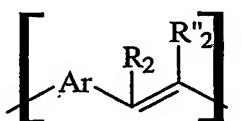
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(54) Title: POLYMER, METHOD OF ITS PREPARATION, AND ELECTRONIC DEVICE

(57) Abstract: A polymer comprising structural units of the formula I has a number average molecular weight of less than 300.103 g/mole and a weight average molecular weight of less than 500.103 g/mole. A preferred example is a polyphenylene-vinylene. A composition of this polymer can be deposited on a substrate by means of inkjet printing excellently. This can be used for the manufacture of electroluminescent devices, in particular multicolor electroluminescent devices.

Polymer, method of its preparation, and electronic device

The invention relates to a polymer with structural units in accordance with formula I,



(I)

in which

Ar is an aromatic cyclic system with 4 to 20 carbon atoms with optionally a single or multiple substitution with a group chosen from a non-branched C₁-C₂₀-alkyl, C₃-C₂₀-alkoxy, C₁-C₂₀-alkylsulphate, a branched C₃-C₂₀-alkyl, phenyl, or benzyl group, and which may optionally comprise up to 4 hetero atoms chosen from the group comprising oxygen, sulfur, and nitrogen in the aromatic cyclic system,

R₂ and R"₂ are chosen from the group comprising a hydrogen atom and a C₁-C₂₀-alkyl and a C₄-C₂₀-aryl group, which groups may optionally comprise substituents.

The invention further relates to a composition.

The invention further relates to a method of preparing polymers with structural units as defined by formula I, a composition of which polymers can be provided on a substrate by means of ink jet printing.

The invention also relates to the use of said composition.

The invention also relates to an electronic device.

Such a polymer is known from WO-A-99/21936. In the known polymer, the group

-Ar- is a multiply substituted phenyl group. The polymer is a polyphenylene-vinylene, which will also be referred to as PPV hereinafter. The polymer is prepared by a method which starts with a monomer of the formula Cl-CH₂-Ar-CH₂-Cl, in which Ar has the same meaning as in the formula I. After addition of a base, polymerization takes place to a polymer having structural units -Ar-CHCl-CH₂-. Then the Cl group is eliminated through heating. This method is known to those skilled in the art as the Gilch synthesis. The PPVs prepared in this manner have electroluminescent properties and are used in light-emitting

diodes and picture screens for this reason. It is desirable in the manufacture of such picture screens to provide a layer of the PPVs by means of ink jet printing.

Experiments carried out by applicant have shown that a layer of PPVs of the formula I cannot be provided on a substrate by means of ink jet printing without special
5 measures.

It is a first object of the invention to provide a polymer of the kind mentioned in the opening paragraph, a composition of which can be provided on a substrate by means of ink jet printing.

10 It is a second object of the invention to provide a composition of the kind mentioned above which can be provided on a substrate by means of ink jet printing.

It is a third object of the invention to provide a method of the kind mentioned above by means of which the polymer according to the invention can be prepared.

15 It is a fourth object of the invention to provide an electronic device of the kind mentioned above comprising the polymer of the invention.

The first object is achieved in that the polymer has a number average molecular weight which is below $300 \cdot 10^3$ g/mole, and in that the polymer has a weight average molecular weight which is below $500 \cdot 10^3$ g/mole. It was surprisingly found that
20 compositions of the polymer according to the invention are well printable. Various problems, however, arise with compositions of the polymer having a higher number average molecular weight. It was found first of all that the head of the printing unit used for ink jet printing is clogged up very quickly and thus becomes useless. Secondly, a higher molecular weight is found to make the elongational viscosity so high that no droplets are formed during printing,
25 but threads. This considerably slows down the printing. In addition, the risk of the polymer being deposited in an undesirable location on the substrate is considerably increased by the formation of threads. Thirdly, a layer of the polymer of a non-uniform thickness is often obtained. The result of this is that the device will not meet the relevant specifications.

The inventors have observed that the invention is of particular importance for
30 conjugated polymers with a - conjugated - chain of alternating single and double bonds which are delocalized. According to the theory of organic chemistry, double bonds exist as a result of overlapping p-orbitals. The result of this is that a double bond lies in a flat plane and has a strongly reduced flexibility. According to a model from the dynamics of polymeric liquids - the reptation model -, diffusion in a polymeric liquid takes place mainly in a one-

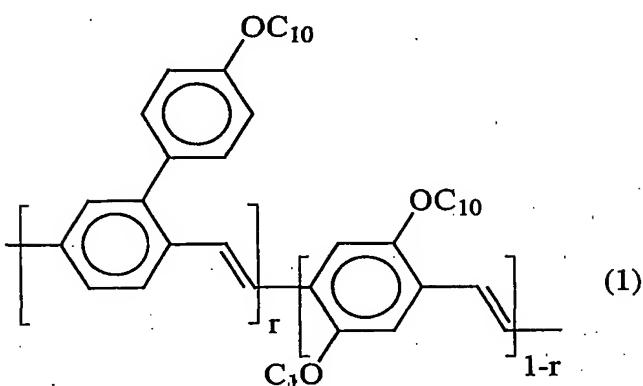
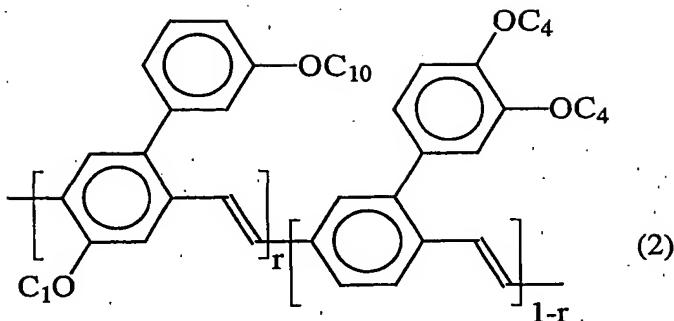
dimensional manner in the direction of the chain. Owing to the smaller flexibility of the conjugated chain and – probably – more densely packed polymer chains, the diffusion of the conjugated chain is thus less than that of the non-conjugated chain. It is by no means surprising for these reasons that other polymers such as polyvinylcarbazoles, and diluted
5 solutions of precursor polymers known from EP-A-892028 behave differently. Indeed, the compositions known from EP-A-892028 with 0.75% by weight of precursor polymer, a usual concentration, are even found to be not or badly printable by means of ink jet printing.

The polymer according to the invention preferably is a PPV. Examples thereof preferably comprise as the –Ar-group an aromatic group chosen from:

- 10 1,4-phenylene, 2,6-naphthalenediyl, 1,4-naphthalenediyl, 1,4-anthracenediyl, 2,6-anthracenediyl, 9,10-anthracenediyl, 2,5-thienylene, 2,5-furanediyl, 2,5-pyrrolediyl, 1,3,4-oxadiazole-2,5-diyl, 1,3,4-thiadiazole-2,5-diyl, 2,5-benzo[c]-furanediyl, 2,5-benzo[c]-pyrrolediyl, 2,5-benzo[c]thienylene, thieno[3,2-b]thiofene-2,5-diyl, pyrrolo[3,2-b]pyrrole-2,5-diyl, pyrene-2,7-diyl, 4,5,9,10-tetrahydropyrene-2,7-diyl, 4,4'-biphenylene, phenantrene-2,7-diyl, 9,10-dihydrophenantrene-2,7-diyl, dibenzofurane-2,7-diyl, dibenzothiophene-2,7-diyl, carbazole-2,7-diyl, of which the nitrogen-containing groups may be substituted on the nitrogen atom with a C₁-C₂₂-alkyl or C₂-C₁₀-aryl group, while in all said groups the H atoms in the aromatic rings may be substituted by a C₁-C₂₂ linear or branched alkyl group, C₄-C₁₄-aryl group, electron-donating groups such as C₁-C₂₂ linear or branched alkoxy and alkylthio groups, and halogen atoms, or electron-attracting groups such as cyano, nitro, and ester groups, while the C₁-C₁₄-aryl group itself may be substituted by electron-donating or electron-attracting groups.
- 15
- 20

By further preference, the –Ar group is an aryl-1,4-phenylene group, in which the aryl group is a phenyl, naphtyl, or biphenyl group which may or may not be substituted.

- 25 In particular, the –Ar group is present in a copolymer, such as the copolymers of formula (1) and (2), in which OC₁₀ represents 3,7-dimethyloctyloxy, OC₄ represents 2-methylpropoxy, and 0 ≤ r ≤ 1, r being preferably approximately equal to 0.5:



5

10 The polymer may alternatively be, for example, a polythienylene-vinylene, which polymer is used as an organic semiconductor in thin-film transistors. These and similar polymers comprise the unit of formula IV chosen as their aromatic group -Ar-,

15



in which

X is chosen from the group comprising O, S, NR₆,

R₃ and R'3 may possibly be identical and are chosen from the group

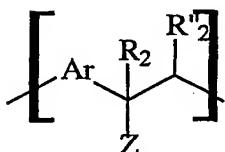
20 comprising the atoms of hydrogen, chlorine, bromine, fluorine, and iodine, and the C₁-C₄-

alkyl, carbonitryl, trihalomethyl, hydroxy, nitro, amino, carboxyl, sulphoxyl, sulphonate, and carbonate groups, and substituted and non-substituted phenyl, alkylaryl and arylalkyl, alkoxy, and thioalkoxy groups, and

5 R₆ is chosen from the group comprising a hydrogen atom and a C₁-C₂₀-alkyl, aryl, C₁-C₂₀-alkylaryl, and arylalkyl group.

The polymer according to the invention with a number average molecular weight of below 300. 10³ g/mole may be obtained inter alia through the preparation of the polymer of formula I from a polymer of the formula II, in which Z is equal to a halogen chosen from among F, Cl, Br, and I; whereupon an ultrasonic aftertreatment takes place of a 10 composition comprising the prepared polymer and a solvent.

(II)



It was found that the aftertreatment provides a decrease of the average molecular weight. The inventors suspect, without wishing to be bound by this supposition, 15 that aggregates are destroyed and/or crosslinks between chains are removed in the aftertreatment. The ultrasonic aftertreatment provides not only a decrease in the average molecular weight, but also a narrower molecular weight distribution. A composition comprising the polymer is found to be stable after the aftertreatment. It was further found that the ultrasonic aftertreatment has no adverse effect on the operation of an electronic device in 20 which a layer of the polymer, in particular of the PPV, is used. The aftertreatment preferably lasts 10 to 20 minutes and is carried out at 0 to 30 °C. Preferably, Z is identical to Cl.

It is alternatively possible to obtain the polymer according to the invention by a different synthesis route such as described in applicant's application no. EP 00201911.5 (PHNL000311) not previously published.

25 The polymer is made into a composition also comprising a solvent so as to be provided as a layer on a substrate. It was found that the composition according to the invention does not suffer a strongly increased elongational viscosity. The composition behaves as a Newtonian liquid during printing. Furthermore, the composition preferably comprises usual auxiliary substances such as wetting agents like glycerin and diethylene- 30 glycol. It is also possible to use a mixture of solvents. The composition may advantageously be made available in a reservoir of an ink jet printer.

Preferably, the composition comprises between 0.5 and 2.0% by weight of the polymer, said polymer having a number average molecular weight of between 75.10^3 and 300.10^3 g/mole, and a weight average molecular weight of between 150.10^3 and 500.10^3 . Experiments have shown that such a composition has a reasonable to good printing quality. If 5 the polymer is a PPV, the printed layer is found to be suitable for use as an electroluminescent layer in an electroluminescent device. By further preference, the composition comprises 1.0 to 1.5% by weight of the polymer, said polymer having a number average molecular weight of between 75.10^3 and 225.10^3 g/mole, and a weight average molecular weight of between 150.10^3 and 450.10^3 . Such a composition has a good printing 10 quality. The electroluminescent device manufactured therewith provides a luminescence which complies with the requirements set.

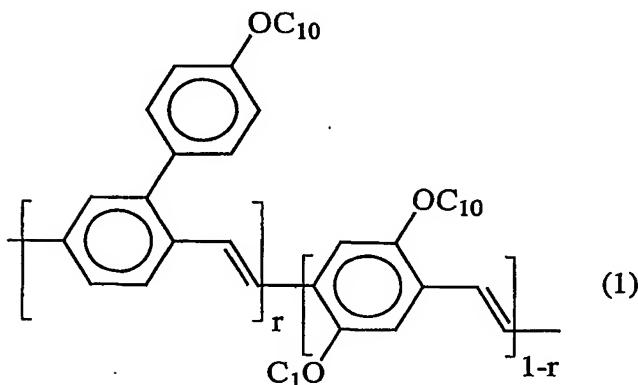
The object of providing an electronic device is achieved in the device according to claim 9. This device is especially characterized in that the polymer has a number average molecular weight below 300.10^3 g/mole. It is possible because of this comparatively 15 low molecular weight to provide the layer of the polymer by means of ink jet printing. The layer can be provided in a desired pattern in this manner. It is possible, moreover, to provide several patterns next to one another on the substrate. An electroluminescent device with more than one color can be obtained in this manner. For example, a first pattern comprises a PPV which emits yellow light; a second pattern comprises a PPV which emits green light, and a 20 third pattern comprises a PPV which emits red light. Such PPVs are known per se. It is furthermore possible for a first pattern to comprise a PPV, while a second pattern comprises a different electroluminescent material, such as a polyfluorine. Such polyfluorines are also known per se.

25 These and other aspects of the polymers, the composition, the method, and the electronic device according to the invention will be explained in more detail below with reference to a Figure, a Table, and a description of the Figures, in which:

Table 1 lists the printing properties of compositions according to the invention, and Fig. 1 is a diagrammatic cross-sectional view of a first embodiment of the 30 electronic device.

Embodiment 1

A polymer of the formula (1) in which $-OC_{10}$ represents 3,7-dimethyloctyloxy, and r is 0.5, is prepared by a method comparable to the method known from WO99/21936. This polymer will also be referred to hereinafter as NRS-PPV.



5

The NRS-PPV has a number average molecular weight M_n of approximately 9.10^5 g/mole, and a weight average molecular weight M_w of approximately 2.10^6 g/mole. It is used in a 1.2% by weight solution in toluene. This is found to be not printable. A vessel containing the solution is placed in an ultrasonic device which is commercially available under the designation Bransonic B32 for an aftertreatment at room temperature. The aftertreatment is carried out during a period of 4 hours. The treatment is interrupted every hour for determining the molecular weight. After two hours, M_n is $3.9.10^5$ g/mole and M_w is $8.9.10^5$ g/mole. The solution is found to be somewhat printable. After four hours, M_n has become $2.3.10^3$ g/mole and M_w $6.0.10^3$ g/mole. The solution is found to be reasonably printable. This treatment is indicated in Table 1 as "soft US", accompanied by the duration of the treatment.

Embodiment 2

A vessel with an untreated solution of NRS-PPV in anisole was placed in an ice bath. The solution, no. 25 in Table 1, had an M_n value of $4.5.10^5$ g/mole and an M_w value of $5.3.10^5$ g/mole. This solution was first subjected to a soft US treatment for seven hours. Then a rod system was added to the vessel for an ultrasonic treatment. The rod system was a Branson Sonifier 450. The solution was subjected to an ultrasonic treatment at a power of 280 W for 13 hours. The treatment was carried out in a pulsatory manner, ultrasonic vibrations being generated during 60% of the time. Afterwards the number average molecular weight and the weight average molecular weight were determined. The results were: M_n =

170.10³ g/mole, M_w = 110.10³ g/mole, and the solution was well printable. This treatment was denoted "harsh US" in Table 1, with the treatment duration in hours.

Embodiment 3

5 An ink reservoir of an ink jet printer was filled with a composition of a PPV treated in accordance with embodiment 1, approximately 1% by weight of PPV being present. The ink reservoir was placed in an ink jet printer with a single-nozzle piezoelectric ink jet head with a nozzle diameter of 50 µm (supplied by Microdop GmbH).

10 Printing was carried out by means of the ink jet printer on a glass substrate covered with a layer of indium-tin oxide (ITO) and further provided with a relief pattern of lines and cavities. Said relief pattern was formed through the application, exposure, and development of a photoresist such as the AZ 4562 photoresist from Hoechst. The distance between the substrate and the nozzle of the ink jet head was set for 1.0 mm, while the ink jet head was moved parallel to the lines of the relief pattern and was positioned above the center 15 of a depression to be filled between the lines. The initial average height of a liquid layer deposited by the ink jet head h_{ini} was equal to f.V/U.B, in which f is the ink jet droplet frequency, V is the droplet volume, U is the velocity of passage of the substrate with respect to the ink jet head, and B is the width of the depression between the lines. In a first example of printing of the NRS-PPV solution, f, V, U, and B were set as follows: f = 300 Hz, V = 220 20 pl, U = 0.03 m/s, and B = 260 µm, which resulted in a h_{ini} value of 8.5 µm. It was subsequently tested whether the composition could be printed.

The result is given in Table 1. Not printable means therein that no stable formation of droplets was possible. The printer head formed threads, e.g. droplets with filaments. These filaments broke up into undesirable small satellite droplets and may thus 25 strongly interfere with the landing position of the droplet. As the ratio M_n/M_w increased, the length of the filament increased. The influence of the high M_w was so strong in some cases that no drop emerged from the printing head at all.

Table 1: printing quality of compositions after an ultrasonic treatment, soft US and harsh US denoting the types of ultrasonic treatment as discussed in embodiments 1 and 2, defined in hours, while the molecular weights M_w and M_n are given in g/mole.

No.	Solvent	Concen- tratio- n [g/l]	Visco- sity 40s-1	Visco- sity 500s-1	Soft US [h]	Harsh US [h]	$M_w/10^3$	$M_n/10^3$	Printing Quality
1	tetraline	8,81	11,6	11,0	21	10	170	90	Good
2	phenetole	9,92	7,5	7,1	22	20	190	110	Good
3	4-methyl-anisole	9,24	10,9	8,5	14,5	12	250	130	Good
4	anisole	7,56	8,4	6,8	23	0	370	150	Good
5	anisole	11,47	12,4	9,3	29	7,5	265	150	Good
6	anisole	8,86	8,5	7,7	7	13	310	170	Good
7	4-methylanisole/o- xylene 3:1	8,40	8,7	8,2	16	12	350	170	Good
8	anisole	8,80	11,3	9,6	32	0	400	180	Good
9	o-xylene	7,93	9,5	8,3	22	13	390	180	Good
10	anisole/o-xylene 1:1	11,7	13	12,5	23	24,5	380	190	Good
11	anisole/o-xylene 1:1	8,1	8,8	8,6	9,5	12	400	190	Good
12	o-xylene	7,81	9,4	9,6	16,5	20	400	200	Good
13	anisole/o-xylene	8,89	9,3	9,3	15	10	450	210	Good
14	o-xylene/anisole	8,98	11,9	11,4	13,5	30	440	215	good
15	toluene	7,81	8,7	8,1	21	0	490	220	Reasonable
16	toluene	5,99	6,5	6,1	4	0	600	230	Reasonable
17	o-xylene	9,00	17,3	16,3	52	0	520	240	Moderate
18	anisole/o-xylene 3:1	8,29	13,3	12,0	20	0	500	250	Not printable
19	anisole/o-xylene 1:1	8,89	23,4	19,1	9,5	0	690	290	Not printable
20	toluene	6,72	14.7		4	0	880	310	Not printable
21	toluene	6,75	18.1		3	0	980	320	Not printable
22	toluene	5,99	7,60	7,12	2	0	890	390	Moderate
23	toluene	6,85	16.1		2	0	840	400	Not printable
24	toluene	6,52	25.2		1	0	1100	420	Not printable
25	anisole	4,3	11.0	11.7	0	0	530	450	Not printable

Embodiment 4

Of the above experiments, those numbered 11, 13, and 19 were repeated, a multinozzle ceramic printing head with 64 nozzles being used for printing, each nozzle 5 having a diameter of 50 μm . The results were found to be unchanged.

Embodiment 5

Fig. 1 diagrammatically and in cross-section shows a first embodiment of the electronic device 10. This device 10 comprises a substrate 11, a first electrode layer 12, a first relief structure 13, a hole injection layer 14, an electroluminescent layer 15, and a second electrode layer 16. The substrate 11 comprises soda lime glass with a thickness of 1.1 mm. The first electrode layer 12 of ITO is provided in a conventional manner on the substrate 11 10 in a pattern of 280 μm wide lines and 30 μm wide openings. The first electrodes are thus obtained in the form of row electrodes. These row electrodes act as the anodes of the 15 electroluminescent elements 1.

The substrate is subsequently covered with a layer of a negative photoresist AZ5218-e (AZ Hoechst) by means of spin coating (1000 rpm). The photoresist is irradiated in a pattern by means of a mask. The photoresist has a pattern of lines and openings of 20 and 290 μm , respectively, which pattern is at right angles to the row electrodes in the vicinity (40 20 μm interspacing). A dose of 230 mJ/cm^2 is used for the exposure. Then the photoresist is cured at 110 °C for 10 minutes and exposed without a mask to a dose of 400 mJ/cm^2 , whereupon the photoresist is developed through the use of a 1:1 AZ developer: DI water 25 developer during a period sufficient for obtaining a negative angle of 45°. Then the entire assembly is given an aftertreatment at 100 °C for 15 minutes. The result is a relief structure 13 of lines and openings, with a line width of 30 μm and openings of 280 μm . The openings are situated above the first electrodes in this case. Each line has the shape of an upside-down trapezium, measuring 30 μm at the top and 20 μm at the base. The height of the relief structure 13 is 5.0 μm .

A solution of poly-3,4-ethylenedioxothiophene (PEDOT) and 30 polystyrenesulphonic acid in water with a 3% solids content is provided over the relief pattern by means of spin coating at 2000 rpm. This results in a wet layer with an average thickness of 8.3 μm . During spincoating, the wet layer is dried at 130 °C for 3 minutes. This results in a patterned hole injection layer 14 of PEDOT with a thickness of 250 nm and a square resistance of 100 MΩ/square.

Subsequently a solution of 0.6% by weight of the ultrasonically treated NRS-PPV is provided by means of ink jet printing as described in embodiment 3. The electroluminescent layer 15 is formed by the ink jet printing process.

Then a 3 nm thick layer of Ba and a 200 nm thick layer of Al is deposited,
5 together forming the second electrode layer 16, on the electroluminescent layer 15. During this deposition, the relief structure 13 serves as a shadow mask. The second electrode layer 15 forms a plurality of column electrodes (cathodes).

The electroluminescent device 10 thus obtained is packed in an envelope which is sealed off by means of an epoxy glue. A quantity of BaO is present in the envelope
10 so as to act as a water getter.

Embodiment 6

Embodiment 5 is repeated, an ultrasonically treated solution of the NRS/PPV having formula (1) being printed in a first, third, and fifth cavity. Subsequently an
15 ultrasonically treated solution of the PPV having formula (2) is printed in a second, fourth, and sixth cavity. The cavities in this case have dimensions of 60 by 60 μm . The result is a two-color device, the first, third, and fifth cavities emitting yellow light during operation ($\lambda = 590 \text{ nm}$), and the second, fourth, and sixth cavities emitting green light during operation ($\lambda = 550 \text{ nm}$). Alternative embodiments printing in three or more colors are also possible on the
20 basis of this principle. It is furthermore possible that not only PPVs, but also other electroluminescent polymers such as polyfluorines are used.

CLAIMS:

1. A polymer with structural units in accordance with formula I,



5 in which

Ar is an aromatic cyclic system with 4 to 20 carbon atoms with optionally a single or multiple substitution with a group chosen from a non-branched C₁-C₂₀-alkyl, C₃-C₂₀-alkoxy, C₁-C₂₀-alkylsulphate, a branched C₃-C₂₀-alkyl, phenyl, or benzyl group, and which may optionally comprise up to 4 hetero atoms chosen from the group comprising oxygen, 10 sulfur, and nitrogen in the aromatic cyclic system,

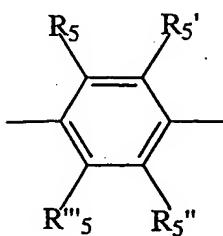
R₂ and R''₂ are chosen from the group comprising a hydrogen atom and a C₁-C₂₀-alkyl and a C₄-C₂₀-aryl group, which groups may optionally comprise substituents, characterized in that the polymer has a number average molecular weight which is below 300.10³ g/mole, and in that the polymer has a weight average molecular weight which is 15 below 500.10³ g/mole.

2. A polymer as claimed in claim 1, characterized in that the number average molecular weight lies between 75.10³ and 225.10³ g/mole, and in that the weight average molecular weight lies between 150.10³ and 450.10³ g/mole.

20

3. A polymer as claimed in claim 1, characterized in that -Ar- in formula (1) stands for:

25



in which R₅, R'₅, R"₅, and R'"₅ are chosen from the group comprising the atoms of hydrogen, chlorine, bromine, fluorine, and iodine, and the C₁-C₄-alkyl, carbonitril, trihalomethyl, hydroxy, nitro, amino, carboxyl, sulphoxyl, sulphonate, and carbonate groups, and optionally substituted phenyl, alkylaryl, and arylalkyl, alkoxy, and thioalkoxy groups.

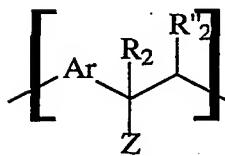
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4. A polymer as claimed in claim 1, characterized in that the polymer is obtainable through:

preparation of the polymer having structural units in accordance with formula I from a polymer having structural units in accordance with formula II, in which Z is a halogen chosen from F, Cl, Br, and I; and subsequently

10

an ultrasonic aftertreatment of a composition comprising the prepared polymer and a solvent.



15

(II)

5. A composition comprising a solvent and a polymer as claimed in any one of the preceding claims.

20

6. A composition as claimed in claim 5, characterized in that the polymer is present in a concentration of between 0.5 and 2.0% by weight, wherein the number average molecular weight of the polymer is greater than 75.10³ g/mole and the weight average molecular weight of the polymer is greater than 150.10³ g/mole.

25

7. A method of preparing polymers defined by the formula I, a composition of which polymers can be provided on a substrate by means of ink jet printing, which method comprises the steps of:

preparing the polymers with a number average molecular weight of more than 300.10³ g/mole, and

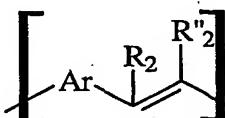
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an ultrasonic aftertreatment in which the number average molecular weight drops to below 300.10^3 g/mole.

8. The use of the composition as claimed in claim 5 or 6 for ink jet printing of a layer of a polymer comprising structural units in accordance with formula I on a substrate.

9. An electronic device provided with a patterned layer comprising a polymer with structural units of the formula I on a substrate,

10



(I)

in which

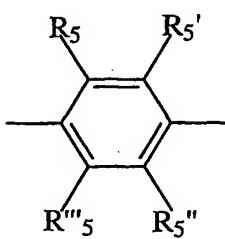
Ar is an aromatic cyclic system with 4 to 20 carbon atoms with optionally a single or multiple substitution with a group chosen from a non-branched C₁-C₂₀-alkyl, C₃-C₂₀-alkoxy, C₁-C₂₀-alkylsulphate, a branched C₃-C₂₀-alkyl, phenyl, or benzyl group, and which may optionally comprise up to 4 hetero atoms chosen from the group comprising oxygen, sulfur, and nitrogen in the aromatic cyclic system,

R₂ and R''₂ are chosen from the group comprising a hydrogen atom and a C₁-C₂₀-alkyl and a C₄-C₂₀-aryl group, which groups may optionally comprise substituents, characterized in that the polymer has a number average molecular weight which is below 300.10^3 g/mole, and in that the polymer has a weight average molecular weight which is below 500.10^3 g/mole.

25 10.

An electronic device as claimed in claim 9, in which -Ar- represents:

30

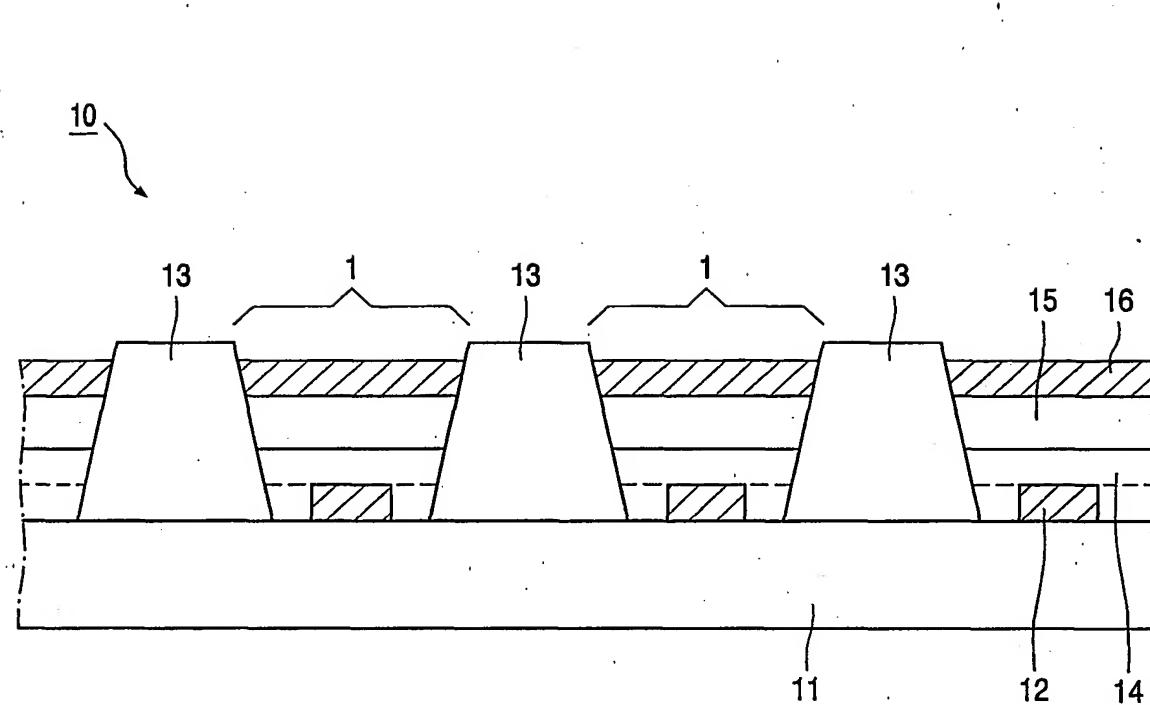


in which R₅, R'₅, R''₅, and R'''₅ are chosen from the group comprising the atoms of hydrogen, chlorine, bromine, fluorine, and iodine, and the C₁-C₄-alkyl, carbonitril, trihalomethyl,

hydroxy, nitro, amino, carboxyl, sulphoxyl, sulphonate, and carbonate groups, and optionally substituted phenyl, alkylaryl and arylalkyl, alkoxy, and thioalkoxy groups.

11. An electronic device as claimed in claim 10, characterized in that a second
5 patterned layer is present on the substrate in addition to the –first– patterned layer, which
second layer comprises a different electroluminescent material than the first layer and is
provided by means of ink jet printing, and
the device comprises a first and a second electroluminescent element, the first element
comprising the first patterned layer and emitting light of a first wavelength during operation,
10 and the second element comprising the second patterned layer and emitting light of a second
wavelength during operation.

1/1



INTERNATIONAL SEARCH REPORT

Inte
al Application No
PCT/IB 02/01880

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C08G61/02 C08F8/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C08G C08F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

PAJ, WPI Data, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, Y	<p>WO 01 92369 A (KONINKLIJKE PHILIPS ELECTRONICS N.V.) 6 December 2001 (2001-12-06) page 2, line 12 -page 4, line 1 page 7, line 17 - line 31 page 8, line 23 -page 9, line 31 page 11, line 31 -page 13, line 9 page 13, line 16 -page 14, line 18 page 15, line 1 - line 25; claims 1-14</p> <p>---</p>	1-11
Y	<p>J. GRUBER: "ELECTROCHEMICAL SYNTHESIS OF POLY(4,4-BIPHENYLENVINYLENE)S (PBPV)" JOURNAL OF MATERIALS. CHEMISTRY, vol. 9, July 1999 (1999-07), pages 1461-1464, XP000887696 page 1461 -page 1464</p> <p>---</p> <p>-/-</p>	1-11

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

* Special categories of cited documents :

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- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

27 August 2002

Date of mailing of the international search report

03/09/2002

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INTERNATIONAL SEARCH REPORT

Inte	al Application No
PCT/IB 02/01880	

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 4 576 688 A (L. D. DAVID) 18 March 1986 (1986-03-18) the whole document ---	1-11
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